

TENSIONS AND EMOTIONAL FACTORS IN REACTION

BY

ELIZABETH DUFFY

A Thesis

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY, IN THE FACULTY OF
PHILOSOPHY, THE JOHNS HOPKINS UNIVERSITY

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I

INTRODUCTION

This investigation was designed to study, in a laboratory situation and with young children as subjects, certain aspects of what is commonly called emotional excitement.¹ The emphasis in the study is on persistent emotional tendencies of the individual, or what we might call the degree of excitability of the individual. For this reason, the measures have been taken over a period of time, each individual's score being represented by 11 different measures.

The measures employed are records of the degree of tension in the muscles of the hand. A task is assigned to the subject (specifically, the pressing of a key whenever a red light appears), and, during the performance of this task, a kymographic record is made of the degree of tension in the muscles of the unused hand. The tension is indicated by the pressure on a rubber bulb, or tube, held in the hand during the performance. This measure, undoubtedly crude, was sufficiently delicate to yield striking differences in tension between individuals, for such differences, at any rate in the child and very probably in the adult also, are quite gross.

¹The use of the terms "emotional excitement," "emotion," and "excitability" in this Introduction is not thoroughly in accordance with what the writer considers to be the most accurate usage. This terminology is employed because it agrees best with current psychological assumptions and seems likely to make the work most intelligible.

The records of tension secured in this way were related to other types of data about the individual. In the first place, these measures were related to subjective estimates of the excitability of the individual and to any evidences of excitability contained in the records of the Child Institute of The Johns Hopkins University. This was done as a check on the objective data and also as a means of analyzing wherein lay the discrepancies between objective and subjective data on this topic. In addition, the introduction of excitative stimuli during the taking of the last four measures of tension and the observation of the effect of these stimuli on the tension line afforded an objective check on the meaning of the tension records.

In the second place, the measures of tension were related to measures of performance. This was done from two points of view, first, the relation of tension to average quality of performance, and, secondly, the relation of tension to variability in performance. The measure of performance was the number of correct responses in the discriminatory reactions to the lights.

The data obtained in the analyses sketched above afforded very interesting suggestions as to the significance of muscular tensions in the individual. Some positive evidence was obtained and many new problems were opened up.

The historical antecedents of this investigation are many and varied, but the only one of direct bearing on the problem is an investigation by Buford Johnson (7) in which she obtained measures of tension in the muscles of the hand during a tapping performance

and related these measures to the quality of the performance. Tension was measured by means of a specially constructed tapping stylus. She found striking individual differences in tension, and states that the experiment proceeded from the theory that "temperamental differences are indicated by differences in tension of expressive muscles under differing stimuli, and that the hand shares with the vocal muscles in frequency and intensity of contraction under emotional stimulation."

A theory of the sort involved here finds much support in psychological literature on the emotions. Emotion is considered, by many psychologists, to be very closely tied up with action and, to this extent, with one of the chief effector systems of the animal organism, namely, the skeletal musculature. Whately Smith (9) may be quoted in support of this position. "An emotion one might say is an undischarged action. Perhaps it would be more accurate to say that emotion is *a state of preparedness* for action, which, however, in many ways is almost the action itself. The involuntary nervous system is excited in the same way as in action A state of tonus is produced in the same voluntary muscles that would be innervated to produce the action itself."

Crile (2), in enumerating the changes in bodily function in an animal driven strongly by emotion, comments that "All these are adaptations to increase the motor efficiency of the mechanism All the lesser emotions—worry, jealousy, envy, grief, disappointment, expectation—all these influence the body in this man-

ner, the consequences depending upon the intensity of the emotion and its protraction The effect of the emotions upon the body mechanisms may be compared to that produced upon the mechanism of an automobile if the engines are kept running at full speed while the machine is stationary."

The experimental work of Cannon (1) indicates that certain emotions possess the function of mobilization of the energy of the organism for greater activity. From acceptance of this position, it requires but one further step to assume that, if the energy is not released in overt activity, it will result in tension of the skeletal muscles.

In fact, muscular tension has at times been observed in experimental work on the emotions, though, in most instances, too little attention has been given to it. Edith Totten (10), in investigating oxygen consumption during emotional stimulation, found indications of tension of the muscles of the arms and legs. We quote from her summary: "Fourteen experiments were performed in which emotional states were definitely induced In six there were shown apparent increases of oxygen consumption following emotional stimulation In all six of these experiments the records show indications of tension of the muscles of arms and legs."

A number of investigators have noted that people differ with regard to excitability. F. S. Hammett (6), of the Wistar Institute of Anatomy and Biology, says, "It is a matter of common observation that there are two extremes of temperament to be found, between

which all gradations of behavior occur. Among persons there is a group of calm phlegmatic individuals with every evidence of a high threshold and a low irritability in their affective response to excitation; and on the other hand there is a group of excitable persons of low threshold and high irritability, whose reactions are out of all proportion to the importance of the exciting cause."

Moreover, this excited state is, in the opinion of many investigators, closely linked up with muscle tonus. Hammett writes: "It is a well known fact that excitability tends to the production of a condition of heightened muscular tone, while calmness or lack of emotional strain results in a lower tension." Observations of these differences in tension were made upon rats from two different colonies in the laboratory, one of which was a gentled group and the other of which had had little human contact.

These differences which individuals exhibit with regard to emotional excitability may, it is to be supposed, have far-reaching consequences in other types of reaction of the individual. To quote from Dunlap (4): "The afferent current derived from feelings must go efferently somewhere, to some muscles and glands; and because of the strength of the supply must have important results. If perceptual reactions and thought reactions concurrent with the feeling reactions 'drain' off this efferent current into their channels without seriously altering the course of these channels, the reactions may be extended and intensified, sometimes usefully. In this case the feelings are said to be 'under control.'

The affective discharge may, however, modify the normal discharge pattern of the perceptual and ideational reactions and seriously interfere with their efficiency in making proper adjustments to the environment, or even block the channels altogether, turning the efferent discharge into the channels for the evoking of new emotional responses. In this case the feelings are said to be 'uncontrolled.' "

If the distribution of the emotional activity is not uniform, there may be expected not a mere change of level in the activity, but, as a result of the blocking of some channels of outlet and the flooding of other channels, there may be expected a concentration of power in certain fields, producing special abilities and disabilities (11).

Moreover, there is some reason for believing that a tendency to be emotional is associated with a tendency to be variable in many phases of reaction. Emotion is itself a notably variable factor and, if, in its attachment to an activity, it has the power of usefully intensifying or of disrupting the activity, there is reason to believe that activities will vary more in efficiency with individuals who tend to be emotional than with those who do not. F. S. Hammett (5) claims, as a result of experimental work, that the variability of the intermediary metabolism of the excitable type of individual is relatively greater than that of the unemotional type. Again, the fatigue index for tapping, which is obtained by comparing the difference between the rate of tapping in an early and in a later part of the performance when an individual taps over a long period

of time, has been found to correlate with other criteria of emotion more highly than any except 1 of 19 criteria of emotion (8). Perhaps the evidence points to the expectation of a close association between variability and emotionality.

II

DESCRIPTION OF EXPERIMENT

The experimental procedure was planned for the measurement of the degree of tension in the left or unused hand during a performance that required attention to visual stimuli and discriminatory reactions to be made by the right or other hand. At specific points in the experiment there were introduced stimuli intended to excite the subject. Rating scale estimates of the tendency toward excitability furnished additional data with which to correlate the experimental findings.

APPARATUS

The apparatus consisted, first, of a flashing device driven by a synchronous motor, which flashed lights at regular intervals, in a black box, with a circular aperture 2.5 centimeters in diameter. The arrangement was such that the experimenter could control the order of appearance of the lights, red or white. The click of a telegraph sounder immediately preceded the appearance of any light. The interval between the lights was four seconds, and the duration of the light was four-tenths of a second. The wiring was such that whenever a light flashed it was indicated on a kymographic record. The line representing the appearance of the lights served also as a time line, since they appeared at regular intervals determined by the rate of the synchronous motor.

A key operating against a light spring was mounted

on a rod, with a lever attached, which marked on a kymograph drum. The reaction was made by depressing the key with the right hand.

A tension bulb, for the subject to hold in his left hand, was made of a piece of thin rubber dam, shaped into a tube. The length of the tube was 10 centimeters and the diameter, 2.5 centimeters. It was fastened securely at one end with cork and tape. At the other end it was connected with a rubber tube leading to a tambour which traced a pattern on the kymograph drum. This was very sensitive to any change in pressure on the bulb, and the writing lever was capable of making an excursion of about 8 centimeters' distance in a vertical line. However, an excursion of this length could not be made during the course of the experiment, for the marker for the key was set approximately 3.5 centimeters above the tension marker and prevented any longer excursion. Since in very few instances the pressure exerted was great enough to cause an excursion of greater length than the 3.5 centimeters, this difficulty was minimized.

The air pressure in the tension bulb was regulated by means of a manometer.

The light box was placed on a table in the line of vision of the subject. On the same table was the tension bulb, attached at one end to a block of wood upon which it rested. The position of the tension bulb could be changed as required. Arm-rests were provided for both the right and the left arms. The rest for the left arm was adjustable, which prevented strain in the hand which held the tension bulb.

When the reactor was seated in a chair in front of the table, all other parts of the apparatus were screened from his view. The experimenter, however, could be seen. This seemed unavoidable, since it was necessary for her to observe whether the child was following instructions.

An addition to the original set-up was a hand Klaxon which was adjusted to give a rather sharp tone.

A further addition was the head of a tin cat, whose eyes could be made to light up at intervals. This was placed on the table below the light box. An electric bell which could be rung at any desired time, announced the lighting of the eyes.

SUBJECTS

The subjects were 11 children in the Child Institute of The Johns Hopkins University. Their ages at the beginning of the experiment ranged from 3 years 5 months to 5 years 1 month. Except for the choice of the older children in the Institute, no specific selection was made.

It was believed that young children would be the best subjects for an investigation of muscular tension in its relation to excitement; for, in children, muscular tension seems to find more general expression than in adults. Hence, in measuring tension in any one part of a child's body, the experimenter would less often expect to find a low degree of tension present at times of excitement, when some other part of the body was quite tense. In the case of adults the process of adaptation often seems to have relegated tension to specific parts of the body, leaving other parts entirely relaxed.

PROCEDURE

Part A. The first part of the experiment was designed to secure tension lines and performance records under circumstances where the only stimulation to excitement came, presumably, from the task set for the subjects and from the general laboratory situation. It was thought that a situation of this sort would be a source of sufficient stimulation to yield some indication of differences in excitability, and it seemed that differences demonstrated in this type of situation might be more significant in indicating general reaction tendencies than would differences in response to more violent stimuli, e.g., horn and cat. For these reasons the first part of the experiment consisted of the presentation, on separate days, of an introductory series of 30 lights, and of six subsequent series of 50 lights each, under circumstances which were kept as free as possible from violently exciting stimuli.

Each of the six series of 50 lights was made up of an equal number of red lights and white lights, arranged in chance order and divided into three parts: Part A and Part B containing 15 lights each, and Part C containing 20 lights. The chance order was secured by taking the order of the cards in a shuffled deck. The red cards represented red lights and the black cards represented white lights. There was only one deviation from this order. Whenever more than four cards of any one color came in succession, the numbers exceeding four were removed and replaced at random until no more than four cards of any one color occurred together.

An attempt was made to arrange the separate presentations of series of lights in such a way that, for each subject, they would come on alternate days and at the same hour. This attempt was reasonably successful for a while, but, later, absences necessitated longer intervals between presentations and, in two instances, made it seem advisable to allow the presentations to come on successive days. Although the hour of the experiment was not kept constant, it did not vary widely.

The intervals between the three parts of any one series were constant as to minimum time and nearly constant as to maximum. Between Part A and Part B on each day a cancellation test of 30 seconds was given. The minimum interval after this test was 2 minutes. The minimum interval between Part B and Part C was 1.5 minutes. The child's occupation during this time was, according to choice, either playing with the Goddard Form-Board or watching the adjustment of the kymograph and helping with it if he liked. Each child spent some time in the latter way, for all the children were very much interested in seeing the marks which they had made.

On the first day of the experiment the child was brought into the experimental room "to play with the engine." Since the experimenter had been in contact with the children for several months previously, the situation was, presumably, not a strange one. The subject was allowed to see the engine start and then was shown the light box, with the following comment, "Do you see this box? When I press a button some lights are going to come on in here. One of them will look

like this (pointing to a bit of red paper pasted on the outside of the light box). What do you call this? (Any answer, or no answer, was accepted without correction.) The other light will not look like this. It will look like the lights in your house. Now watch and I'll show them to you." Then 10 lights were presented.

During an interval of 2 minutes the child was allowed to play with a puzzle. Then he was taken back to the apparatus and shown how to press the key and was allowed to do it several times to see whether he could do it correctly. He was seated in a chair in front of the light box in position for the experiment. His right arm was placed on the arm-rest and his right hand rested lightly on the key. His left hand was placed around the tension bulb in such a way that the bulb, supported at one end, was enclosed by the hand, which rested upon the block of wood supporting the bulb, back up. The arm-rest for the left arm was adjusted in such a way that the tension bulb was within easy reach without necessitating a strained position. Then the child was given the following instructions: "Now I am going to show you the lights again. Every time you see the light like this (pointing to red paper), press the button. Let's see if you can do it." The experimenter illustrated with two red lights, each time asking the child to press the key. Then she said, "All right now, *don't* press unless the light looks like this." Two white lights and a red light were given, and the child was corrected if he made a mistake in reacting to any one of them. The instructions were: "Look at the box and try hard. Press only when you see the light like this." Five lights were presented.

After a rest interval of 1.5 minutes the subject was brought back to the apparatus, the essential part of the instructions was repeated, and a record taken of his performance. Thirty lights, divided into three parts of 10 lights each, were presented. Between the presentation of the parts there were rest intervals of 1.5 and 3 minutes.

In general, the same procedure was followed throughout the experiment. Instructions were given always before the first part of the day's series and repeated, or not repeated, before the other parts, according to whether the subject seemed to know what he was to do. It seemed that confusion would result from insistence on instructing subjects who already knew what they were about.

The subject was always placed in the correct position, with particular attention to the way in which the bulb was held. An effort was made not to direct the child's attention to the tension bulb, but, wherever this could not be avoided, he was allowed to play with it before any records were made. When he said he was tired of playing with it and was ready to "play with the engine," the experiment was begun. Sometimes during the course of the experiment, if the subject showed an obvious tendency to play with the bulb, the experimenter cautioned him not to do so. These cautions were given between parts of the experiment or else the whole procedure was stopped until the caution had been given. In this way there was no interference with reactions to the lights.

Toward the end of the experiment the offer of simple

rewards, such as seeing a green light, was sometimes necessary in order to secure cooperation.

Part B. The second part of the experiment was in all particulars like the first, except that at certain intervals, and without warning to the subject, the hand Klaxon was sounded. There were two series of lights—the eighth and ninth—during which the horn was used. In the first of these series it was sounded after the fifth and twelfth lights in Part A, and after the third, fifth, and tenth lights in Part B. In the second of the series it was sounded after the third, fifth, and tenth lights in Part A, and after the fifth and twelfth lights in Part B. In neither of the series was it used during Part C, though, before this part of the experiment was begun, the subject's attention was called to the fact that it *might* be sounded.

The distraction of the horn was great enough in some instances to prevent the subject from attending to the lights. During Parts A and B of the first series, the experimenter cautioned him to look at the lights whenever she observed that his attention was wandering. This caution was not repeated during Part C, nor in any part of the second series.

The horn, which was very loud, proved an effective stimulus. Almost all the children spontaneously expressed dislike for it, one or two of them using expressions such as, "It makes me scared in my stomach." Several of them begged not to have it sounded again. There was, however, a difficulty in the use of it. This was the fact that the sounds produced were, at different times, not entirely alike, for their character depended

upon such factors as the speed and force with which it was sounded and the tightness of some of the screws. These factors were controlled in so far as possible, but the experimenter believes that, nevertheless, they did to some extent influence the results.

Part C. The third part of the experiment differed from the first part only in the fact that the tin cat was used. The cat was placed on the table under the light box and was screened from the subject's view by means of a piece of cardboard which could be removed when the experimenter pulled a string. After the first exposure the screen was not replaced, but, at stated intervals during the series of lights, the eyes of the cat were made to light up with a yellow glow, showing red centers. Each lighting of the eyes was preceded, at varying intervals, by the ringing of an electric bell. There were two series of lights, the tenth and eleventh, during which the cat was used. During the first of these series the bell was rung after the second and ninth lights in Part A, the second and seventh in Part B, and the second and twelfth in Part C. The cat's eyes were lighted after the third and eleventh lights in Part A, the fifth and eleventh in Part B, and the seventh and sixteenth in Part C. During the second series the bell was rung after the second and eighth lights in Part A, the fifth and eleventh in Part B, and the third and tenth in Part C. The cat's eyes were lighted after the fourth and twelfth lights in Part A, the third and tenth in Part B, and the sixth and thirteenth in Part C.

The lighting of the eyes seemed to be a mildly pleas-

ing stimulus to the subjects, and after the experiment was completed they asked, in several instances, to be allowed to see them light again. Watching for the lighting of the eyes seemed in some instances to increase attention to the experiment.

Part D. As a means of securing other data on certain general reaction tendencies of the subjects, the following rating scale was prepared and sent to the parents of the children and to those in the Institute who had most intimate contact with them. It was requested that all ratings be done independently.

RATING SCALE

If 1 represents the least degree of the quality under consideration and 5 the greatest degree of that quality, locate the child you are rating somewhere on the scale from 1 to 5 for each of the qualities listed below. The rating which you are asked to do involves the comparison of the child in question with other children of the same age. To illustrate, you might check as below:

1	2	3	✓	4	5
---	---	---	---	---	---

I. Using as an indication of excitement tensing of the muscles and other observable signs:

A. How frequently does he become excited during the ordinary activities of the day?

1	2	3	4	5
---	---	---	---	---

B. How likely would he be to feel excitement, whether or not freely displayed, if he were asked to perform a new and difficult task?

1	2	3	4	5
---	---	---	---	---

C. How likely would he be to become excited if he saw something which he wanted very much and could not get immediately?

1	2	3	4	5
---	---	---	---	---

II. How intense or to how great extent would he be excited in each of the instances named above?

1	2	3	4	5
---	---	---	---	---

III. How long would the excitement last in each of the instances named above?

1	2	3	4	5
---	---	---	---	---

IV. How much ability has he to inhibit, or stop, a reaction which he may wish to inhibit, such as crying?

1	2	3	4	5
---	---	---	---	---

V. In building something or in other constructive play, how careful and precise is he?

1	2	3	4	5
---	---	---	---	---

SCORING OF RECORDS

Scoring of Responses to Lights. Pressure of the key in response to the appearance of a red light and no pressure of the key in response to the appearance of a white light were scored as correct responses.

Scoring of Tension. The tension was scored with reference to the height of the tension line above the base line. Before each of the three parts of a day's record was made, a base line was run off to determine the position of the tension pointer on the drum when no pressure was being exerted on the tension bulb. Height above this base line in terms of half-centimeter units was taken as the score for the tension. A score of 1 means that the tension line did not rise as much as a half-centimeter above the base line. A score of 2 means that it rose as much as 1 unit, but less than 2 units, above the base line. If the tension line touched the line marking the next higher division, it was scored as being in that division.

Distance on the perpendicular line was used as the basis of scoring, and no account was taken of the fact that the excursion of the pointer on the drum was represented by a line which curved in its upper extent. This seemed justifiable in view of the fact that less than half of the maximum excursion of the pointer was allowed to record. Hence, the part of the excursion on the drum was practically a straight line.

The height of the tension line was measured in this way throughout its extent, and a score was recorded for each interval from the appearance of one light to the appearance of another, that is, for each 4-second interval. The score recorded was, in each instance, that of the highest tension registered during the interval. The tension present, then, during a single experimental sitting (or any one series of the experiment) was represented by 50 separate tension scores. These 50 scores were averaged to give the average tension for the day. These averages will be found listed in Table 1.

Scoring of the Ratings. To secure a score which would indicate the judgment of the raters as to a subject's tendency toward excitability, an average was taken of all ratings on Parts A, B, and C of Question I of the Rating Scale. Table 2 shows these averages.

III

TABLES OF RESULTS

TABLE 1
AVERAGE TENSION SCORES

	Series number											
	1	2	3	4	5	6	7	8	9	10	11	Av.
<i>Subject: B.J. (Boy)—4 yrs.</i>												
A	1.00	1.13	2.33	4.53	1.07	1.73	1.27	1.53	1.93	1.00	1.00	1.68
B	1.00	2.60	3.47	4.93	2.13	1.00	1.13	3.13	2.00	1.24	1.00	2.15
C	1.60	3.60	2.40	1.50	1.65	1.45	1.00	2.35	2.75	1.04	1.00	1.85
Av.	1.20	2.44	2.73	3.65	1.62	1.39	1.13	2.34	2.23	1.09	1.00	1.89
<i>Subject: C.H. (Girl)—4 yrs. 8½ mos.</i>												
A	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.41	1.04
B	1.00	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.07	2.00	1.23	1.12
C	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.05	1.00	1.14	1.02
Av.	1.00	1.023	1.00	1.00	1.00	1.00	1.00	1.00	1.06	1.33	1.26	1.06
<i>Subject: D.M. (Boy)—3 yrs. 8 mos.</i>												
A	7.30	5.53	6.66	3.40	4.93	2.40	5.26	1.86	3.47	4.06	4.58	4.58
B	6.10	3.86	4.25	4.93	5.73	3.66	4.33	4.46	5.06	3.17	2.06	4.33
C	5.60	4.85	4.40	5.20	3.70	4.20	2.35	5.45	4.55	2.27	2.72	4.12
Av.	6.30	4.48	4.79	5.59	4.28	4.26	3.03	5.06	3.82	2.97	2.97	4.34
<i>Subject: D.S. (Boy)—4 yrs. 2 mos.</i>												
A	2.40	2.80	4.40	6.07	4.00	1.87	2.00	1.07	1.00	1.00	1.82	2.58
B	1.60	3.30	4.73	3.56	1.87	2.60	1.87	1.00	1.27	1.06	1.18	2.27
C	1.30	3.90	3.55	...	1.90	1.20	1.10	1.00	1.00	1.17	1.64	1.78
Av.	1.77	3.30	4.23	4.81	2.59	1.89	1.66	1.023	1.09	1.08	1.55	2.21
<i>Subject: E.D. (Girl)—4 yrs. 6 mos.</i>												
A	1.00	1.00	1.00	1.00	1.00	1.13	1.20	1.00	1.00	1.00	1.00	1.03
B	1.00	1.13	1.13	1.13	1.27	1.87	1.00	1.00	1.94	1.06	1.00	1.21
C	1.00	1.60	1.15	1.05	1.75	1.35	1.00	1.00	1.10	1.05	1.00	1.19
Av.	1.00	1.24	1.09	1.06	1.34	1.38	1.066	1.00	1.35	1.04	1.00	1.14
<i>Subject: J.B. (Boy)—5 yrs.</i>												
A	1.00	2.00	1.00	1.33	5.47	6.69	1.13	2.07	1.38	1.12	1.53	2.25
B	4.40	1.00	1.47	1.00	1.67	1.73	1.20	2.00	1.73	1.23	2.05	1.77
C	4.30	1.00	1.00	3.85	5.20	1.05	1.00	1.15	1.00	1.04	1.41	2.00
Av.	3.23	1.33	1.16	2.06	4.08	3.16	1.11	1.74	1.37	1.13	1.66	2.01
<i>Subject: O.E. (Boy)—3 yrs. 6 mos.</i>												
A	1.00	1.00	1.07	1.00	1.00	1.00	1.00	1.07	1.13	1.00	1.18	1.04
B	1.00	1.00	1.13	1.27	1.27	1.33	1.00	1.00	1.93	1.00	1.00	1.18
C	1.00	1.05	1.00	1.00	1.30	1.05	1.60	1.30	1.05	1.00	1.36	1.16
Av.	1.00	1.017	1.07	1.09	1.19	1.13	1.20	1.12	1.37	1.00	1.18	1.13

TABLE 1 (*cont.*)

	Series number											
	1	2	3	4	5	6	7	8	9	10	11	Av.
<i>Subject: P.M. (Girl)—4 yrs. 2 mos.</i>												
A	2.00	2.87	1.20	4.07	4.67	4.87	5.67	3.20	6.94	2.27	2.48	3.66
B	2.30	2.93	6.53	4.60	5.07	4.53	5.80	6.20	5.80	4.00	1.67	4.49
C	4.10	1.53	5.20	5.20	5.40	4.75	5.10	3.60	7.75	2.68	2.13	4.31
Av.	2.80	2.44	4.31	4.62	5.05	4.72	5.52	4.33	6.83	2.98	2.09	4.15
<i>Subject: P.X. (Girl)—5 yrs. 1 mo.</i>												
A	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B	1.00	1.00	1.00	1.00	1.07	1.00	1.00	1.00	1.00	1.00	1.00	1.006
C	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.09	1.008
Av.	1.00	1.00	1.00	1.00	1.023	1.00	1.00	1.00	1.00	1.00	1.03	1.005
<i>Subject: R.L. (Girl)—3 yrs. 5 mos.</i>												
A	1.00	1.07	1.00	1.00	1.20	2.40	1.07	1.00	1.00	1.00	1.00	1.16
B	1.00	1.07	1.00	1.94	4.60	2.80	1.07	1.53	1.33	1.00	1.00	1.67
C	1.00	1.00	1.00	1.65	3.85	3.68	1.05	1.00	1.00	1.00	1.00	1.57
Av.	1.00	1.05	1.00	1.53	3.22	2.96	1.06	1.18	1.13	1.00	1.00	1.47
<i>Subject: V.R. (Boy)—4 yrs. 11½ mos.</i>												
A	1.00	1.20	3.60	3.47	1.40	1.67	6.47	3.40	1.87	1.00	1.00	2.37
B	2.60	2.93	5.62	2.93	2.47	5.13	4.13	2.53	1.67	1.53	1.00	2.96
C	1.20	2.50	4.81	1.00	1.60	4.45	4.90	1.50	1.00	1.14	1.00	2.28
Av.	1.60	2.21	4.68	2.47	1.82	3.75	5.17	2.48	1.51	1.22	1.00	2.54

TABLE 2
RATING SCALE ESTIMATES

Subject	Average rating on excitability
B. J.	4.41
C. H.	3.04
D. M.	3.94
D. S.	3.41
E. D.	2.80
J. B.	3.33
O. E.	3.19
P. M.	3.81
P. X.	3.33
R. L.	2.80
V. R.	3.06

TABLE 3
PERCENTAGE OF CORRECT RESPONSES TO THE LIGHTS

Subject	Part I								Part II			Part III		
	Series number													
	1	2	3	4	5	6	7	Av.	8	9	Av.	10	11	Av.
B. J.	87	98	88	94	82	94	94	91.3	80	98	89	94	98	96
C. H.	87	98	98	100	96	100	98	97.3	96	100	98	98	100	99
D. M.	60	58	58	56	46	80	76	62.2	82	84	83	94	80	87
D. S.	100	98	98	100	96	96	96	97.5	96	98	97	96	100	98
E. D.*	53	78	78	76	80	72	74	74.2	76	66	71	46	60	53
J. B.	76	84	70	64	68	64	86	73.1	66	56	61	74	72	73
O. E.	63	50	76	93	72	74	82	72.6	80	90	85	86	92	89
P. M.	77	72	76	58	68	72	76	69.4	82	74	78	90	82	86
P. X.	93	94	98	86	94	96	98	94.3	98	92	95	100	92	96
R. L.	97	92	90	82	80	90	90	88.3	96	86	91	90	98	94
V. R.	93	100	95	88	98	94	98	95.2	88	96	92	98	98	98

*All of E. D.'s scores are open to question.

IV

DISCUSSION OF RESULTS

THE RELATION OF TENSION TO EXCITEMENT

One of the first questions to be considered is the relation between excitement and tension of the muscles, as measured in the experiment.

It will be recalled that the measures of tension were taken from the muscles of the unused hand. Under these circumstances it is conceivable that tension may or may not have been present in other parts of the body. According to the theory advanced by Buford Johnson (7) in a recent article, if tension is present it is most likely to be found in the muscles of the hand or in the vocal muscles.

The evidence we have for the correlation between excitement and tension, as measured here, falls into three categories: first, the comparison of ratings on excitability with the degree of tension shown in the experiment; secondly, the effect on the tension records of specific excitative stimuli; and, thirdly, the difference between the effect of these stimuli on the performance of subjects with low tension scores and the effect of the same stimuli on the performance of subjects with high tension scores.

Comparison of Degree of Tension and Ratings on Excitability. Let us consider first the ratings. If we take the average of all ratings on A, B, and C of Question I, we have a composite score representing the judg-

ment of the raters as to the likelihood of the child to become excited under the three classes of circumstances listed in that question. This may be taken, we believe, as an estimate of the child's tendency toward excitement. For comparison with this we have the average tension score made by each subject in the experiment. This score was obtained by taking the average of the averages obtained for each subject for Parts A, B, and C. If we arrange the subjects in rank order, proceeding from highest to lowest, first, in rating on excitability, and secondly, in tension score, we have the following arrangement.

Rating on Excitability*				Average Tension Scores*			
1.	Subject	B. J.	4.41	1.	Subject	D. M.	4.34
2.	"	D. M.	3.94	2.	"	P. M.	4.15
3.	"	P. M.	3.81	3.	"	V. R.	2.54
4.	"	D. S.	3.41	4.	"	D. S.	2.21
{ 5.	"	J. B.	3.33	5.	"	J. B.	2.01
{ 6.	"	P. X.	3.33	6.	"	B. J.	1.89
7.	"	O. E.	3.19	7.	"	R. L.	1.47
8.	"	V. R.	3.06	8.	"	E. D.	1.14
9.	"	C. H.	3.04	9.	"	O. E.	1.13
{ 10.	"	E. D.	2.80	10.	"	C. H.	1.06
{ 11.	"	R. L.	2.80	11.	"	P. X.	1.005

*The scores in the two columns are *numerically* comparable only *within* the column, and not between the two columns.

It will be noted that there is quite a fair degree of correspondence between the ranks of the subjects in the two columns. If rank 6, which is the median, is taken as the dividing line between those having a high rank and those having a low rank, it will be observed that those in the upper half of one column are located in the upper half of the other column also, with three

exceptions. For these exceptions there are certain explanatory facts which should be considered.

Subject V. R., who ranked lower in excitability than his tension score would indicate, is a child who is decidedly inhibited. There is every reason to suppose, however, that there is often a high degree of excitement beneath his restrained exterior. When younger, he suffered from mutism, which is often found associated with excitability. The fact that the disturbance in his case took the form of mutism rather than stammering confirms the opinion that he has a strong tendency toward inhibition. Such a child would probably be rated as less excitable than one whose reactions were more overt. But in the tension score this excitement would be revealed.

The second exception is B. J., who is ranked highest in rating on excitability and holds the median place in tension score. B. J. is a subject who is decidedly deficient in inhibition. Excited states are readily shown and, as his tension scores indicate, there are a number of times when he is, in a high degree, excited. Observations of his unrestrained reactions at such times would tend to make a person rating him place him high in rank on excitability. Moreover, his average tension score, though the median score, would place him well toward the upper end of the scale in tension, for there is twice as great a difference between it and the next *lower* score as there is between it and the next *higher* score.

The third exception is Subject P. X. This subject has the median rank in rating on excitability and the

lowest rank in tension score. In this case it is difficult to determine whether the tension score is at fault as an indicator of the general tendencies of the subject in respect to excitability or whether the rating is at fault. It may be that P. X. is fairly easily excited, and that the experimental situation provided for her no stimulation of this sort. She seemed to take the task rather nonchalantly and talked frequently during the performance. It is possible, too, that the rating on excitability is too high, for P. X. talks a great deal and is very active. As an example of her type of reaction we may consider her response to the sounding of the horn during the experiment. She said, in a very casual tone, "Oh, that scares me to death!"

Subject R. L., while falling into the lower half of both columns, has a tension rank which is four places higher than her rating on excitability. This is easily accounted for by analysis of her tension records. There are only two days on which she has an average tension score exceeding two. On these days it was noted that she was playing with the tension bulb.² The high scores made at that time raise her average score above its true level. A low and comparatively smooth line, such as that shown in Figure 6, is characteristic of her tension line on all other days.

With these exceptions the ranks in the two columns correspond very closely. In fact, there are no other

²As the reader may suspect, there were other subjects who played with the bulb from time to time, but in the experimenter's opinion this did not materially affect the tension scores and certainly did not affect the tension ranks. R. L. was a subject who was less amenable to control than any of the other subjects.

cases in which the rank of a subject in one column differs more than one or, at the most, two places from his rank in the other column.

The numerical values in the two columns are not to be compared, for they are based on entirely different units.

The rank correlation of the two columns is approximately .56 with a P.E. of approximately .15.

The Effect of Excitative Stimuli on the Tension Records. An examination of the tension records on the days when specific excitative stimuli were introduced indicates that these stimuli had, in many cases, a decided effect on the tension lines.

Their influence is shown in two ways. First, by sharp rises in the line at the moment of their introduction, and, secondly, by higher average tension scores for some subjects on the days when they were used. The latter effect occurs less frequently, due perhaps to the fact that the stimuli were used on the last four days of the experiment when the tension would, because of adaptation, be expected to be lower than at an earlier time. The character of the stimuli may also be partly responsible for this result. The sounding of the horn, the ringing of the bell, or the lighting of the cat's eyes are, possibly, sudden stimuli, hardly intense enough to produce a lasting effect, yet capable at times of producing a great momentary effect. At any rate, the various tension lines quite often show decided rises and quick returns to a lower level following the introduction of one of these stimuli. The change caused by the horn is more likely to be a very high rise and an *im-*

mediate return of the line to the previous level. That caused by the cat is more likely to be a *less high* rise and a *less sudden* return to the former level.

The effects we have described did not occur with all subjects, nor even with the same subject on all occasions. But this is hardly a surprising fact, for no so-called excitative stimulus is such a stimulus for all people or at all times. Individual differences in the effect produced by these stimuli are in many ways more interesting than any central tendency. These should be carefully observed.

*Effect of the Klaxon.*³ An analysis of the records on days eight and nine of the experiment, when the horn was used, shows that the following effects were produced.

1) Subject V. R. had very high rises of the tension line following every sounding of the horn but one. In most instances the line returned immediately to its former level, but in two instances it sloped down gradually.

2) Subjects D. M. and P. M. showed very sudden rises in the tension line on some, but not all, occurrences of the horn. They both showed greatly increased average tension on one or another of the days when the horn was used. P. M. reached her highest tension score for the entire experiment on the second of these days. D. M. had his third highest tension score on the first of these days—and this in spite of the fact that until that time his scores showed a gradual decline from an initial high score.

3) The tension line of Subject J. B. showed a very

³See Figure 8.

high and sudden rise upon two occasions when the Klaxon was sounded. The immediate return of the line to its former level makes it obvious that this stimulus was the cause of the sudden rise. On no other occurrence of the horn was any effect observable, and it is characteristic of J. B.'s reactions, in general, that a stimulus which might produce a very great effect at one time might produce no effect at all at other times.

4) In B. J.'s record it was difficult to determine the degree of influence of the horn. What we find on the two days when this stimulus was used is a *very great* increase in height and irregularity of line over that recorded for the three previous or the two following days. But there are no sudden rises of the line which are unmistakably attributable to this stimulus, for the general irregularity obscures any effect which the stimulus may have had. However, the very great increase in average tension probably should be regarded as an effect of the horn.

5) The tension line of O. E., upon one occasion when the horn was blown, showed a very high rise with almost immediate return to the previous level, and at other times when the stimulus occurred it showed slight wavers. His highest average tension score during the 11 days was recorded on the second day of this part of the experiment. The tendency of this subject to be affected by the Klaxon is very interesting. He had the third lowest average tension score, but he was ranked two places higher in the rating on excitability.

6) The tension line of Subject D. S. showed definite small jumps on many occurrences of the horn.

The effect of the stimulus was not great, but is very definitely recorded.

7) The tension line of Subject R. L. showed almost imperceptible wavers at times when the horn was sounded. She had slightly higher tension scores on those days than on any other day except two.

8) The tension lines of Subjects E. D., P. X., and C. H. showed practically no effect from the Klaxon. The records of the first two showed no change at all, while C. H.'s showed at times very slight wavers. On one of these days she raised her usual tension score of 1.00 to 1.06. No other effects are discernible.

It is interesting to note that these three subjects have the ranks 8, 10, and 11 in average height of tension score and that the ratings place them among the less excitable subjects.

*Effect of the cat and bell.*⁴ The cat and bell as excitative stimuli seemed less effective than the horn. An analysis of the records shows that the tension lines were affected as follows:

1) For Subject D. M. there were many sudden jumps in the line when the bell was rung and when the cat's eyes lighted, but only one or two of these variations seemed definitely due to the new stimulus. The other variations could be a part of the general irregularity of the line.

2) For Subject J. B. there were three moderately high rises in the line that were definitely due to the cat as a stimulus.

3) With Subject V. R., the cat was without ques-

⁴See Figure 9.

tion the cause of one rise in the line. Four other rises coincident with the lighting of the eyes may have been produced by this stimulus or may have been a part of a general irregularity of line unrelated to this source of excitation.

4) The tension line of Subject D. S. showed many definite rises upon the lighting of the cat's eyes. These rises were not very great, but the tension score on the second day of the cat's appearance was much higher than on the three preceding days.

5) For subject P. M. one moderate rise in the line seems definitely due to the cat as a stimulus, and one greater rise seems due to the bell. If there were any other effects from these stimuli they were obscured by the general irregularities of the line.

6) One extremely slight rise in the line of Subject P. X. seems due to the cat, and another to the bell. With these exceptions there seemed to be no effects from the stimuli.

7) The tension lines of Subjects O. E., E.D., R. L., B. J., and C. H. showed no effect whatever from the stimuli, with one exception. C. H.'s line showed a *very* slight rise once when the bell was rung. Moreover, her tension scores are slightly higher on these two days, but an examination of the records throws some doubt upon the reliability of this difference.

It is interesting to note that in average height of tension score these subjects occupy the ranks 6, 7, 8, 9, and 10.

Effect of specific incidents. During the course of the experiment several incidents occurred which throw light upon the interpretation of the tension lines.

There was, first, the case of Subject D. S., who, on the third day of the experiment, after he had completed Part A, refused to go on with Part B. He was not permitted to leave the room. He became very much aroused over the situation, but finally expressed willingness to continue the performance. His tension line in Part B is very high—noticeably higher than in Part A or Part C (see Figure 4).

A second incident worth considering occurred with V. R. on the fourth day of the experiment. Parts A and B of the day's series had been completed, and high and rather irregular tension lines had been recorded. As the subject was being placed in position for Part C, the arm-rest dropped. V. R. laughed. While the experimenter picked it up and adjusted it, he talked to her. This was a remarkable bit of relaxation for V. R., for he is generally very restrained and talks little. The tension line for Part C, taken immediately afterwards, is low and regular, rising very little above the base line.

The Effect of Excitative Stimuli on Performance.

A comparison of the percentage of correct responses in Series 8 and 9, when the horn was used, and in Series 10 and 11, when the cat and bell were used, with the percentage of correct responses in Series 1 through 7, when no specific excitative stimuli were used, enables us to observe the effect on performance of these stimuli (see Table 4). However, the effect of learning in the later series complicates the comparison. We should, under ordinary circumstances, expect improvement in score in these later series. Therefore, the instances in

which we have not improvement but a decrease in score may be regarded as significant.

TABLE 4

AVERAGE PERCENTAGE OF CORRECT RESPONSES IN THE THREE PARTS OF THE EXPERIMENT

Series 1 through 7 Subject	Score	Series 8 and 9 Subject	Score	Series 10 and 11 Subject	Score
D. S.	97.5	C. H.	98 (+)*	C. H.	99 (+)
C. H.	97.3	D. S.	97 (—)	D. S.	98 (+)
V. R.	95.2	P. X.	95 (+)	V. R.	98 (+)
P. X.	94.3	V. R.	92 (—)	P. X.	96 (+)
B. J.	91.3	R. L.	91 (+)	B. J.	96 (+)
R. L.	88.3	B. J.	89 (—)	R. L.	94 (+)
E. D.	74.2	O. E.	85 (+)	O. E.	89 (+)
J. B.	73.1	D. M.	83 (+)	D. M.	87 (+)
O. E.	72.6	P. M.	78 (+)	P. M.	86 (+)
P. M.	69.4	E. D.	71 (??)	J. B.	73 (+)
D. M.	62.2	J. B.	61 (—)	E. D.	53 (??)

*Scores are marked + or — according to whether they represent a gain or a decrease in relation to the subject's score in the previous part of the experiment.

In making the comparison it seems advisable to disregard the scores of E. D., for it was impossible during these later series to interpret her responses with any degree of accuracy.

The scores of the other subjects, then, without exception, show improvement in Series 10 and 11. The improvement is shown both with reference to the average percentage correct in Series 1 through 7, and the average percentage correct in Series 8 and 9. The cat and the bell evidently had no deleterious effect upon the performance. We noted in an earlier section that these stimuli had less effect upon the tension line than had the horn.

In Series 8 and 9 we observe that the average percentage of correct responses is, for four of the subjects,

lower than the average percentage correct in the first seven series. This effect may, in all probability, be attributed to the horn. The subjects who show this influence are D. S., V. R., B. J., and J. B.—all of them being individuals with high tension scores. All other subjects show an improvement in score over the average maintained for the first seven series.

We cannot suppose that an improvement in score during Series 8 and 9 necessarily indicates that the horn had no effect on the performance, for the effect exercised by this stimulus might conceivably have been that of increasing the efficiency of the performance. However, this seems unlikely in view of the character of the stimulus. On the other hand, it is quite possible that the excitative stimulus exercised a handicapping effect on some or all of the scores which show improvement, for this effect might have been present and might have been counteracted by the effects of learning—a result which might be expected particularly in the case of subjects who had a very low rank in performance and who, therefore, had much room for learning. Within this category fall Subjects D. M., P. M., and O.E., who held the lowest ranks in Series 1 through 7 and who improved both their ranks and their absolute scores very considerably in Series 8 and 9.

We may, on the other hand, suppose that a falling off in average score is an indication that the performance was handicapped by the introduction of the excitative stimulus, for improvement due to learning is what might be expected under any other circumstances. It is interesting to observe that this decrease in score

does not occur with a single subject who had an average *tension* score *below* the median. Nor does it occur with all subjects who had *performance* scores *above* the median in Series 1 through 7 (which would offer a good opportunity for the effect to show), but rather with all those who had *both* tension and performance scores *above* the median, thus indicating that, where the effect had the opportunity to manifest itself, it did so with those who had high tension scores and did not with those who had low tension scores. This fact suggests that a high tension score is correlated with a tendency to be affected by excitative stimuli.

Summary. The evidence presented indicates a very close correlation between muscular tension and excitement, and makes it seem more than probable that habitual tendencies in muscular tension are indicative of habitual tendencies in respect to excitability.

The ratings on excitability by the individuals in closest contact with the subjects correspond very closely with the average height of tension score of the subjects. If these two classes of evidence did not correspond very closely, the hypothesis would not be disproved, for one or the other of the measures might possess inaccuracies, but a close degree of correspondence between the two is hardly likely to be explained by accident.

The specific excitative stimuli in many instances caused a sudden rise in the tension line. Moreover, this rise in the line occurred more frequently with the subjects who had high average tension scores and were rated high in excitability than with the other subjects.

Accidental occurrences during the experiment tend to support the general trend of the evidence in regard to the effect of excitative stimuli on the tension line.

Finally, those subjects whose performance records were adversely affected by the sounding of the Klaxon were, without exception, subjects with high tension scores, thus further indicating that a high tension score is correlated with a tendency to be affected by an excitative stimulus.

TYPES OF TENSION LINE

Having stated, from the evidence presented in the first part of the discussion, that habitual tendencies in muscular tension seem indicative of habitual tendencies in respect to excitability, we have to some extent prepared the way for a study of individual differences in tension. One of the most clear-cut results of the experiment was the tendency it revealed for the tension line of a subject on one day to correspond very closely in form to his tension line on any other day.⁵ This consistency in form of line throughout the 11 non-consecutive days seems to indicate that, in recording a subject's tension, we are securing data on certain fundamental reaction tendencies of the individual and, to this extent, are obtaining information about certain aspects of his temperament.

Perhaps we can best arrive at an understanding of the significance of the tension line through an analysis of the various types of tension line recorded in the ex-

⁵Compare Figures 1, 2, and 3 which were made from the records of one subject on three consecutive days.

periment and a consideration of the traits which characterize the individuals who produced the records. The files of the Child Institute proved to be an excellent source of information upon the characteristics of the subjects of the experiment, for in the files were found descriptions of the behavior of the children as observed (1) by the individuals in the Institute who had charge of the various groups of children, and (2) by the individuals who had given the children specific tests, such as the Stanford Revision Test and the Pintner-Patterson Performance Test. The first group of observers recorded descriptions of characteristic behavior during the day, and the second group of observers recorded descriptions of behavior during the time the child was engaged in taking the tests. The observations were in no instance made by persons who had any connection with this experiment. The quotations from the observations, as given below, are, naturally, selected because of their bearing upon the questions under discussion. However, no observations not in agreement with the general trend of our results have been omitted.

The types of tension line found among the 11 subjects of the experiment may be classified as follows:

*High and Irregular Tension Line.*⁶ Subjects D. M. and P. M. had the highest average tension scores and the greatest irregularity of tension line. The tension line, though always high, changes rapidly from one level to another and has in most places a rather wavy appearance, though there are also many sharp peaks.

⁶See Figures 1, 2, and 3.

The Institute files contain the following descriptions of these children.

1) Subject D. M.

Stammers—especially when asking questions about something he is particularly interested in.

Does not always relax well. Muscles often too tense. Is the only one in the group who has not succeeded in staying absolutely quiet and relaxed for at least five minutes during the rest period.

Needs to be encouraged to hold over his impulses and not so often plunge into situations without forethought.

Quick. Prefers active occupations through which he can let off surplus energy. At times seems overflowing with good spirits and madly races around the room. Has not learned self-control upon these occasions. His danger lies in exhaustion coming through overstimulation and nervous tension.

S. R. Test: Tired easily. Attention wandered.

P. P. Test: Showed much impetuosity. Also showed some impatience when unable to do what was asked. He was interested, however, and could be kept at a task quite a while by the promise of another test soon, which at the moment looked more inviting to him.

2) Subject P. M.

Likes to talk a great deal.

Gets rather tense at times, and has a high shrill laugh which seems to result more from excitement than from real mirth, yet when her laugh expresses mirth it has a similar quality.

Worries over things a great deal at times and has a real need of assurance. Asks who is coming for her, does she need a raincoat, etc.

S. R. Test: Got nervous and began talking to herself.

P. P. Test: Talked a steady stream all the time she was working. Her impulses were little controlled either in speech or in the use of her hands. Attention not very good.

The elements in common in the description of these two subjects seem to be those which indicate restless energy, impetuosity or lack of control, and distractibil-

ity. Both are spoken of as giving at many times distinct evidences of excitement.

In relating these characteristics to the type of tension line recorded for the subject, we seem justified, in accordance with the previous section of the discussion, in relating the tendency toward excitement to the extreme height of the tension line. The excess of energy shown by the subjects may also, we believe, be related to this characteristic of the tension line, for, as we have pointed out in the Introduction, an increase in available energy appears to be the very essence of the excited state.

The other outstanding elements in the characterization of these subjects might be termed impetuosity, or impulsiveness, and distractibility. It should, perhaps, be possible to relate these characteristics to the irregularity of the tension lines of these subjects. On this point, however, the evidence is not very clear. More extensive experimentation will be necessary to determine the question. From the data we have we can say, somewhat vaguely, that the irregular tension line is characteristic of the individual who does not have himself well in hand. Perhaps it is an indication of lack of coordination of response. From some points of view it might be considered an indication of what Downey (3) calls "degree of impulsion." These two interpretations, though not identical, are similar in trend. The greater the degree of impulsion the more difficult is coordination, and therefore the more likely it is that it will not be attained. Excitement typically increases the degree of impulsion and jeopardizes coordination. Therefore, the high tension line indicative of excite-

ment is more likely to show irregularities than is the low tension line. On the whole, irregularity of tension line seems most reasonably attributed to poor coordination. Though a high degree of impulsiveness does seem to jeopardize coordination, yet coordination is quite possible under these circumstances, and though inhibition seems favorable to good coordination, it does not always produce it, as is seen in the case of Subject V. R. in this experiment. The speech difficulties from which he suffers, which tend in the direction of mutism, give an excellent example of inhibition coupled with poor coordination. His tension line is noticeably irregular. But the discussion of this subject is out of place in this section.

The two subjects whose records are being analyzed here showed, in addition to the traits discussed above, a decided tendency toward distractibility. This trait was listed in the characterizations by observers in the Institute and came out in addition in the poor scores they made on the discrimination reactions required in this experiment. The distractibility may, we believe, be looked upon as one of the expected consequences of poor coordination, for good attention involves a very complex and difficult coordination.

A tension line of the *very* irregular type recorded for these subjects we should not expect to find among adults, for with them adaptation, involving coordination, has probably progressed beyond this point. These two children seem to be still in a low stage of coordination. They have a great problem to handle.

*High and Regular Tension Line.*⁷ The tension line

⁷See Figure 4.

of Subject D. S. was, in general, high, but quite even, sloping gradually downward from the beginning to the end of any part of a day's record and becoming very much lower on the latter days of the experiment. He ranked fourth highest in average tension score, but the evenness of his tension line is in striking contrast to the irregularities of the high tension lines of D. M. and P. M.

In accordance with the method of interpretation which was employed in discussing high and irregular tension lines, we should expect such a tension line as this to indicate an individual who is very susceptible to excitement, but who is particularly well coordinated.

The Institute files contain very few relevant characterizations of this subject, chiefly, perhaps, because he has himself so well in hand that he does not constitute a problem in the Institute. The few remarks on record are the following.

1) Subject D. S.

Stubborn.

Muscular coordination excellent.

P. P. Test: Persistent and patient. Good motor control.

The fact that D. S. gave the best performance of any of the subjects in making the discriminatory reactions indicates that he is capable of excellent coordination.

He was the subject who refused on one day to continue the experiment but who finally went back to the task in a very emotional state, but well-controlled enough to give an almost perfect performance.

On the whole, these few remarks indicate what general observation confirms, that is, that D. S. has a rather strong tendency to become excited, but that he has himself well in hand, or is well coordinated.

*Moderately High Tension Line with Many Peaks.*⁸ The tension lines of Subjects V. R., J. B., and B. J. were more variable from day to day and from one to another part of the same day's record than were those of the other subjects. On one day, or one part of a day's record, the line might be rather low and even, while on another day, or another part of one day's record, it might be high and irregular. But the most regular lines generally showed minor irregularities, and the most irregular lines generally had rather low and even stretches. The most consistent characteristic of these lines was the presence of many high peaks punctuating otherwise fairly even stretches of moderately high tension. These peaks, with J. B., almost always came at the time when he was pressing the key, and with V. R. they often came when he was in all likelihood inhibiting the tendency to press the key. However, his tension line is classified under moderately high tension line with peaks rather than high and irregular tension line, because of the presence of many smooth lines along with the irregular lines we have described. V. R.'s line has a much greater average height than that of B. J. or J. B.

An individual with a tension line of this type might be expected to be rather poorly coordinated at times. We should expect him to be capable of a fairly intense degree of excitement on occasion, but not to be as continually "keyed up" as individuals with a consistently high tension line. V. R., who gave a much higher tension line, on the average, should not be too closely associated with B. J. and J. B. in this respect.

⁸See Figure 5.

The Institute files contain the following remarks about these subjects.

1) Subject V. R.

Under stress of emotion he is inclined to be inarticulate. Suffered from mutism when a young child.

Emotions not freely or spontaneously expressed.

He usually keeps sustained interest in what he is doing, has very definite ideas of what he is trying to do, and works toward that end.

S. R. Test: Strained facial expression.

P. P. Test: His impulses were under control, and he did not paw and reach as many children as interested as he have done.

2) Subject B. J.

Shows marked fluctuations of mood and emotional instability.

Is nearly always the last to come in to relax, but once he gets settled he rests fairly well, provided he is not close enough to touch any one.

In the dining room it is hard to keep him from jumping up from his seat to make investigations or disturbances of one kind or another.

Inability to curb his impulses.

Somewhat careless.

P. P. Test: Motor control and general impulse control is undeveloped. Showed some persistence.

3) Subject J. B.

High shrill voice.

Inclined to stammer a little.

Eats rapidly.

Tears papers and matting and endeavors to distract other children. During the intervals when he resigns himself to remaining quiet at nap time he frequently sucks two fingers.

Often has to be taken out of the group because of his disturbing influence.

Not always persistent in the face of difficulties.

P. P. Test: Attention poor. Motor control fair. Slightly impulsive.

The characterizations of these subjects give evidence

of incoordination and of excitability. B. J. and J. B. are impulsive and show their lack of coordination in restless movements and the creation of disturbances within the group. With them excitability is less marked than incoordination, and this is in accordance with their tension lines, which are irregular but not exceptionally high. V. R. has a tension line which is much higher than that recorded for these subjects, as a comparison of average tension scores will indicate. In view of this fact it is not surprising that he seems to have a greater tendency toward excitement. He is inhibited in his reactions and shows a certain type of control, but his deficiency in coordination is evidenced by his speech difficulties and his frequently strained facial expression.

*Low and Regular Tension Line.*⁹ The tension line characteristic of Subjects P. X., C. H., R. L., E. D., and O. E. is uniformly low and even. R. L. had two records with a different type of line, but these, coming one after the other, are explained by the fact that at this period she developed a great interest in the tension bulb and played with it during the experiment in spite of all that could be done. But, of course, we cannot be certain that there were not other factors also which were responsible for the change. All other tension lines recorded for this subject were low and even.

Subjects P. X. and C. H. had decidedly lower and more regular tension lines than Subjects O. E., E. D., and R. L.¹⁰ The ages of the subjects may have been

⁹See Figures 6 and 7.

¹⁰Compare Figures 6 and 7.

partly responsible for this fact. R. L. and O. E. are the youngest subjects, and, other things being equal, the younger child might be expected to have a more irregular tension line than the older one. On the other hand, this may represent a true difference in excitability, especially in the case of O. E., whose tension line showed at times a decided change when the specific excitative stimuli were introduced.

A tension line of this type is more difficult to interpret than a high tension line. While a high tension line indicates without question the presence of tension, a low tension line does not so unequivocally indicate its absence. There is always the possibility that the tension was present in some other part of the body. But, since the subjects were very young children, this is less to be expected than if we had been experimenting with adults.

If we take these low and even lines as indicating the absence of tension, we should expect to find the subjects who made them fairly free, in most instances, from excitement. Those with very regular tension lines might prove to be exceptionally well-coordinated individuals. At any rate, we should not expect to find among these subjects the special problems of excitement and incoordination which we found among the subjects previously discussed. For this reason it need not be surprising that the Institute files have little to say about these subjects from the point of view of the characteristics which we are considering in this investigation. The remarks on file are the following.

1) Subject E. D.

Carefree attitude coupled with continued effort.

P. P. Test: Motor control excellent. Showed little impatience.

2) Subject C. H.

Relaxes well.

Eats well all that is put before her.

Emotions freely expressed, but she usually achieves a nice balance between expression and repression.

Motor coordination excellent.

Bites nails.

P. P. Test: Impulses well under control while doing work.

3) Subject O. E.

Relaxes well.

Deliberate and thoughtful in his movements.

Persistent.

Motor coordination fine.

4) Subject R. L.

Has learned to relax very well.

Forethought, persistence, and patience.

Good motor control.

Cautious and deliberate.

5) Subject P. X.

Gets wrought up easily.

Chews or sucks the forefinger of her glove.

Impetuous.

Emotions readily expressed.

S. R. Test: Appeared quite restless throughout test. No special interest or efficiency was shown in any part of the test.

P. P. Test: Eager and interested. Motor impulses well controlled. Attention, patience, and persistence were excellent.

The descriptions above, with the exception of that of Subject P. X., correspond very closely with the traits which might be expected on the basis of the form of the tension line. The characteristics common to this group of subjects are: good powers of relaxation, good coordination, and little tendency toward excitement.

The characterization of Subject P. X. is not in accordance with the type of tension line recorded for her.

The explanation, as suggested before, may lie in the fact that she took the experimental situation nonchalantly and did not try to make a good record. This is indicated by the fact that her rank in score on the performance is far below her rank in mental age. If she had really entered into the situation, it is possible that her tension line would have been much higher than the one recorded for her. This further emphasizes the fact earlier pointed out that, while a high tension line seems quite reliable as an indicator of a tendency toward excitement, a low tension line is not quite so reliable as an indicator of the absence of this tendency. Subject P. X. seems somewhat variable in certain reaction tendencies. Compare, for instance, the attitude exhibited when she took the S. R. Test with that shown when taking the P. P. Test. In the former instance, the record says she was restless and showed no special interest or efficiency. In the latter instance, attention, persistence, and patience were excellent, and motor impulses were well controlled. On the basis of this evidence it seems likely that a different variety of experimental situation or a different experimenter might have brought out different reaction tendencies with consequent differences in the tension line.

Another very possible explanation of the discrepancy between characterization and tension line is that the observers of the subject mistook the easy and free expression of "being wrought up" with an actual state of excitement. It will be recalled that, when the Klaxon sounded, this subject said, "Oh, that scared me to death," yet she did not give a start or a movement of any sort, and no one would call her stoical.

Summary. The facts presented above seem to warrant the conclusion that the type of tension line recorded for an individual is significant as an indicator of certain types of reaction tendencies on the part of the individual.

It seems quite clear that the *height* of the tension line is closely related to the tendency of the individual to become excited, a high tension line indicating greater excitability than a low tension line.

It seems less clear, yet very much in accord with available evidence, that degree of regularity or evenness of tension line is closely related to the tendencies in coordination shown by the individual, a very uneven tension line indicating a poorer type of coordination than an even one.

Inasmuch as the type of tension line registered by an individual remained to a striking degree the same on one day as on another, when the measures were taken on 11 days over a period of nearly 3 months, it seems clear that the tendencies indicated by the tension line are fundamental reaction tendencies of the individual and may be taken as indicative of certain aspects of his temperament.

RELATION OF TENSION TO QUALITY OF PERFORMANCE

It was hoped that the experiment would yield a rather definite answer to the question of the relation of tension to quality of performance in making the discriminatory reactions, but from this point of view the results were disappointing. No particular height of tension score or type of tension line seemed *definitely*

associated with any particular quality of performance, though it seems entirely unlikely that there actually is no relationship between these two factors. What seems more probable is that the experiment was not adequate to reveal this relationship. However, the analysis of the results from this point of view does not seem without value and is for that reason presented below.

Relating the average tension scores and the types of tension line to the efficiency of the subjects in making the discriminatory reactions, no particular size of tension score or type of tension line seems to be associated with efficient performance, though there is some evidence that one of the types of line is associated with inefficient performance. In studying the relationship of these factors we must always keep in mind the age of the subjects, for an efficient performance by a younger child is more creditable than the same performance by an older child. The children are so very young that a few months or a year may be important in determining the type of performance. There follows below the rank of the subjects in average tension

Subject		Average tension score	Subject		Average percentage of correct responses	Subject		Age	
1.	D. M.	4.34	1.	D. S.	97.5	1.	P. X.	5 yrs.	1 mo.
2.	P. M.	4.15	2.	C. H.	97.3	2.	J. B.	5 yrs.	
3.	V. R.	2.54	3.	V. R.	95.2	3.	V. R.	4 yrs.	11½ mos.
4.	D. S.	2.21	4.	P. X.	94.3	4.	C. H.	4 yrs.	8½ mos.
5.	J. B.	2.01	5.	B. J.	91.3	5.	E. D.	4 yrs.	6 mos.
6.	B. H.	1.89	6.	R. L.	88.3	6.	D. S.	4 yrs.	2 mos.
7.	R. L.	1.47	7.	E. D.	74.2	7.	P. M.	4 yrs.	2 mos.
8.	E. D.	1.14	8.	J. B.	73.1	8.	B. J.	4 yrs.	
9.	O. E.	1.13	9.	O. E.	72.6	9.	D. M.	3 yrs.	8 mos.
10.	C. H.	1.06	10.	P. M.	69.4	10.	O. E.	3 yrs.	6 mos.
11.	P. X.	1.005	11.	D. M.	62.2	11.	R. L.	3 yrs.	5 mos.

score, in average percentage of correct reactions to the lights, and in age. The percentage of correct reactions is based on the data from the first seven series in which no excitative stimuli were used.

It will be seen that Subject D. S., who has the highest average number of correct responses, has the median rank in age, so his performance may be judged as excellent. He has the fourth rank in height of tension score, and his tension line was of the type called "high and regular." It was suggested that he would be found to be a well-coordinated individual, and the excellence of his performance supports this statement.

Subject C. H., who has the second rank in number of correct responses, has the fourth rank in age. Her performance, too, may be classed as excellent, especially since it so closely approaches a perfect performance. C. H. has the tenth rank in height of tension score, and her tension line is of the type described as "low and regular." She, too, was spoken of as likely to be well coordinated, and her performance supports this opinion.

Comparing the average height of tension score of these two subjects who gave almost perfect performances, we must suppose that height of tension score is not closely connected with efficiency of performance, for D. S. has Rank 4 in tension, and C. H., Rank 10.

The performance of V. R., R. L., and B. J. must also be classed as very good. V. R. had 95.2% correct responses, and holds the same rank in performance that he holds in age. R. L., who holds Rank 6 in performance, has Rank 11 in age. Therefore, she must

be classed among the better performers. B. J., who ranks fifth in performance, ranks eighth in age. He has 91.3% correct responses. These three subjects differ widely in rank in tension score, which further suggests the lack of correspondence between this factor and efficient performance. V. R. ranks third in tension, B. J. sixth, and R. L. seventh. However, R. L. probably should have a lower rank in tension, as was pointed out in the section entitled "Comparison of Degree of Tension with Ratings on Excitability." Her tension line was, in general, "low and regular," while V. R.'s and B. J.'s were classed as "moderately high with many peaks."

If we consider, now, the less efficient performers, there is more evidence for a correlation between height and type of tension line and quality of performance.

Subjects D. M. and P. M. have the last two ranks in number of correct responses and the first two ranks in height of tension score. They were the only subjects whose tension lines were classified as "high and regular." In age they have the Ranks 9 and 7. It is evident that their performance was not very good. If this lack of efficiency is closely related to tension, it is a question whether it is more closely related to average height of tension score or to irregularity of tension line; for these two subjects have average tension scores almost twice as great as that of the subject who ranks third in tension, and the irregularity of their tension lines far exceeds that of the tension line of any other subject.

In considering the height of tension score associated with good performance, no relationship was found to

exist between the two, but the tension scores here considered, while some of them were high in rank, were appreciably lower in absolute value than the scores of D. M. and P. M. Perhaps a moderately high, but not too high, tension score does not lower, or may even raise, the quality of performance, while a *very* high tension score is incompatible with efficiency. There are several bits of evidence which we may consider in connection with this hypothesis, but all the evidence does not point in the same direction. Subject D. S. had tension scores on two days which were as much as a unit higher than any of his other tension scores. These scores were as high as the average tension score of Subjects D. M. and P. M. Yet the efficiency of D. S.'s performance on those two days was no less than on the other days of the experiment. On the other hand, Subject P. M. had tension scores on the first two days of the experiment, which were more than a unit lower than any of her other scores during the first seven days. The percentage of correct responses on these days is appreciably higher than her average percentage correct for the seven days. This is very significant because these two rather high percentages went into the making of the average and are, moreover, scores made at the beginning of the experiment where learning effect could not have contributed to their excellence. On the last two days of the experiment, Subjects D. M. and P. M. had lower tension scores and higher percentages of correct responses, but here it is difficult to allow for the effect of learning. P. M. had an exceptionally high tension score on the day previous to this, when the

horn was used, and on this day the percentage of correct responses is 74 as compared with 90 and 82 on the two days which followed. But Subject D. M., who has a very high tension score on the eighth day of the experiment, has 82% of correct responses on this day as compared with 94% and 80% on days 10 and 11, when the tension score was much lower and the learning had progressed further. Altogether, we are unable to connect definitely inefficiency of performance with a tension score which might be considered too high.

If, on the other hand, we attempt to connect inefficiency of performance with irregularity of tension line, we have slightly more convincing evidence, but we cannot by any means be sure that the relationship is a true one. D. M. and P. M. do have the most irregular tension lines and they have also the smallest percentage of correct responses, though they are not the youngest subjects. D. S. and C. H. have comparatively even tension lines and they have the largest percentage of correct responses in spite of the fact that they are not the oldest subjects. But V. R. and B. J., who on many days have quite irregular tension lines, are rather good performers. An examination of the records of each of the 11 subjects fails to show that a subject makes his best scores on the days when his tension line is most smooth. Subject R. L. does show a decided falling off in score on the three days when her tension line is irregular, but this, as we pointed out, is due to the fact that she was playing with the bulb. However, a rough correspondence may exist between type of tension line and type of performance and this may be hidden by other factors which entered into the records.

We have pointed out in a previous section that irregularity of tension line probably indicates a tendency toward incoordination, and, if this is true, it might be expected to correlate to some extent with inefficient performance. In the same way, a smooth or regular tension line, if it indicates good coordination, might be expected to correlate to some extent with efficient performance. However, it seems that these correlations should not be expected to occur without due consideration of the degree of ability of the subjects in question, for the efficiency of any performance is, to a certain extent at least, a function of the degree of ability of the performer. For this reason it seems advisable to relate to the other two factors in question, that is, type of coordination and efficiency of performance, some measure of the degree of ability of the subjects. Mental age, as measured by the Stanford Revision scale, seems the most feasible thing to use.

The data at hand yield the following ranks in mental age and in performance.

Subject	M. A.	Subject	Average percentage of correct responses
1. P. X.	79 mos.	1. D. S.	97.5
2. C. H.	73 mos.	2. C. H.	97.3
3. V. R.	67 mos.	3. V. R.	95.2
{ 4. D. S.	64 mos.	4. P. X.	94.3
{ 5. P. M.	64 mos.	5. B. J.	91.3
6. E. D.	63 mos.	6. R. L.	88.3
7. J. B.	60 mos.	7. E. D.	74.2
8. O. E.	56 mos.	8. J. B.	73.1
9. R. L.	55 mos.	9. O. E.	72.6
10. B. J.	52 mos.	10. P. M.	69.4
11. D. M.	50 mos.	11. D. M.	62.2

It will be seen, as might be expected, that mental age is an important factor in determining efficiency of per-

formance. However, it is obvious that other factors also enter into the question, for the ranks in mental age do not correspond perfectly with the ranks in performance.

The most important deviations in the ranks in the two columns occur in the case of D. S., R. L., and B. J., who are exceptionally good performers in relation to their mental age, and in the case of P. X. and P. M., who are exceptionally poor performers in relation to their mental age.

Type of coordination, as evidenced in the tension line, does not entirely explain these discrepancies. Of the good performers in relation to *M. A.*, Subjects D. S. and R. L. show in their tension line evidence of good coordination, but B. J. does not always show this type of coordination.

Of the poor performers in relation to *M. A.*, Subject P. X. has a tension line which shows good coordination, while the tension line of P. M. indicates very poor coordination. However, it is possible that P. X., with high *M. A.* and good coordination, had the possibility of giving a good performance but made little effort to do so.

RELATION OF TENSION TO VARIABILITY IN PERFORMANCE

In an attempt to discover whether tension has any relation to the degree of variability in performance, the scores on discriminatory reactions made during the first seven days of the experiment, when no excitative stimuli were introduced, were used as a basis for cal-

culating the coefficient of variation for each subject. This was calculated according to Pearson's formula,

$$V = \frac{100}{av.}. \quad \text{The results appear below.}$$

Subject	Average percentage of correct responses	Coefficient of variation, or V
1. D. S.	97.5	1.68
2. C. H.	97.3	4.47
3. V. R.	95.2	3.91
4. P. X.	94.3	4.02
5. B. J.	91.3	5.16
6. R. L.	88.3	6.00
7. E. D.	74.2	11.47
8. J. B.	73.1	11.60
9. O. E.	72.6	17.48
10. P. M.	69.4	9.93
11. D. M.	62.2	17.70

A comparison of the two columns above will show that the size of the coefficient of variation is very closely related to the size of the average score, the larger average scores showing, in general, smaller coefficients of variation than the smaller average scores. For this reason it appears that the coefficients of variation, unless considered in relation to the averages upon which they are based, are not significant as indicating differences in tendency toward variability. They do, of course, indicate variability in the performance in question, but this variability is not even remotely related to variability considered as a temperamental characteristic, for variability in the performance seems to depend more closely upon the level of efficiency of the performance than upon any other one factor. This is not hard to understand if we keep in mind the fact that the better performers, many of whom approximated a perfect performance on the first day of the experi-

ment, had less room for variation than the poorer performers, who had much room for learning. Because of this fact, variability as here measured is a function of the degree of difficulty of the test for the particular subject.

However, if we consider the coefficient of variation in relation to the size of the average score upon which it is based, it may possibly be of significance. Let us consider, then, the cases in which the rank in coefficient of variation is noticeably lower or higher than the rank in average score on the performance. There are only two cases of this sort. One is the case of C. H., who ranks two places higher in variability than would correspond to her position in the score column. The other case is that of P. M., who ranks three places lower in variability than would correspond to her position in the score column. It seems that O. E. also departs somewhat from close correspondence between size of score and of coefficient of variation. While his scores have the same *rank* in both columns, the size of V is greater than might be expected on the basis of his average score, as may be seen by comparing V in his case with V recorded for Subjects J. B. and E. D., who have approximately the same average performance scores.

Such data as we have, then, would indicate C. H. and O. E. as particularly variable, and P. M. as particularly consistent in performance. C. H. and O. E. have low tension scores and smooth tension lines, while P. M. has a high tension score and an irregular tension line. The evidence does not seem to support the hypothesis that excitability (if we grant that this is indicated by tension

of the muscles) is correlated with variability in performance. Rather the contrary, so far as the evidence in this experiment is concerned. But it must be admitted that the data are very inadequate for drawing any definite conclusion.

V

CONCLUSIONS

1) Tension, as measured in the muscles of the unused hand, seems definitely correlated with excitability. The connection between the two is evidenced by the close correspondence between ratings on excitability and the average height of tension score; by the tendency of specific excitative stimuli to cause a definite rise in the tension line at the moment of their introduction, this rise being more likely to appear in the tension lines of those rated as excitable and having high tension scores than in the tension lines of those rated as less excitable and having lower tension scores; and by the tendency of the horn as an excitative stimulus to cause, with four subjects who had high tension scores, but with no other subjects, a decrease in average percentage of correct responses in Series 8 and 9 as compared with the percentage of correct responses in Series 1 to 7 inclusive, where no specific excitative stimulus was introduced.

2) Type of tension line, that is, height and shape of line, seems correlated with certain general reaction tendencies of the individual and may be held to reveal certain of his temperamental characteristics; for *height* of tension line seems rather definitely correlated with tendency to become excited, and there is some reason to believe that *regularity or smoothness* of tension line is correlated with tendencies in coordination, that is, whether the individual is well or poorly coordinated.

3) The experimental data present no evidence of a definite relation between tension and degree of efficiency in performance. If such a relation exists, it is obscured by other factors. Efficient performance was associated with no particular average height of tension or type of tension line. Inefficient performance was associated, in two outstanding cases at least, with a high average tension score and an irregular tension line, but which, if either, of these factors was intimately connected with the inefficiency, it was impossible to determine.

4) There is no definite evidence of a relation between height or type of tension line and variability in performance. The scant evidence available does not support the hypothesis that excitability is correlated with variability in performance.

PREFATORY DESCRIPTION OF THE PHOTOSTATS

The photostats which follow are taken from the records made during the experiment. Each photostat represents one day's record for a subject. The day's record was divided into three parts, recorded in the order of numbering in the photostat.

In any one of the three parts of the record, three horizontal lines may be seen. The bottom line represents the time of appearance of the lights, each vertical mark in the line signifying the flashing on of a light. The middle line is the tension line. Its base may be determined by observing the height of the line at the left of the record before the bulb was grasped. Here it is a very smooth horizontal line, easily distinguishable from the more irregular one which follows after the subject has grasped the bulb. The top line represents the subject's responses to the lights.

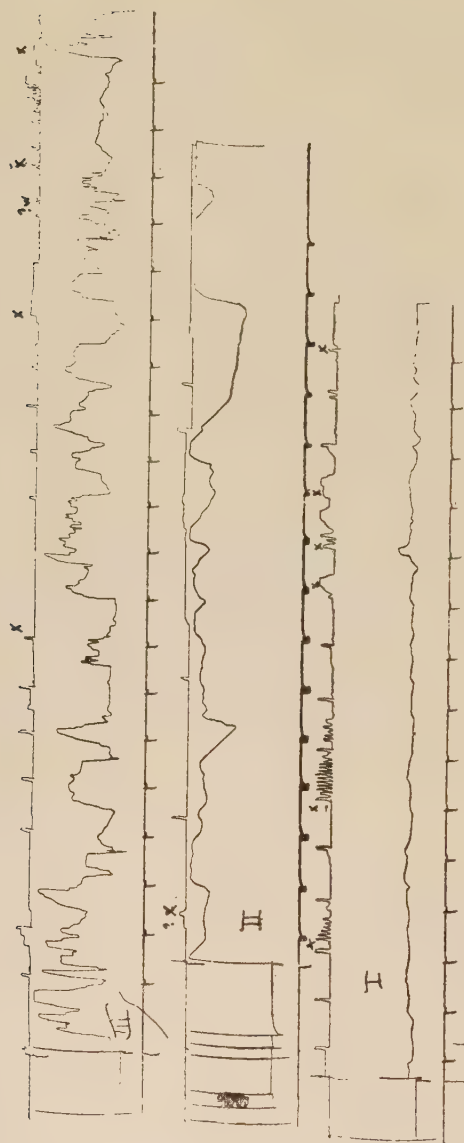


FIGURE 1
RECORD OF SUBJECT P. M., SERIES 3

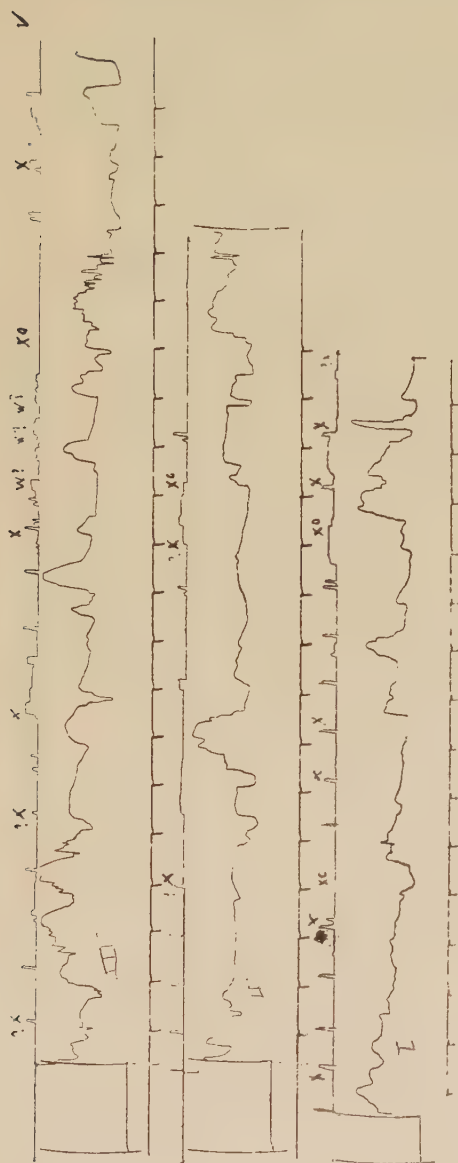


FIGURE 2

RECORD OF SUBJECT P. M., SERIES 4

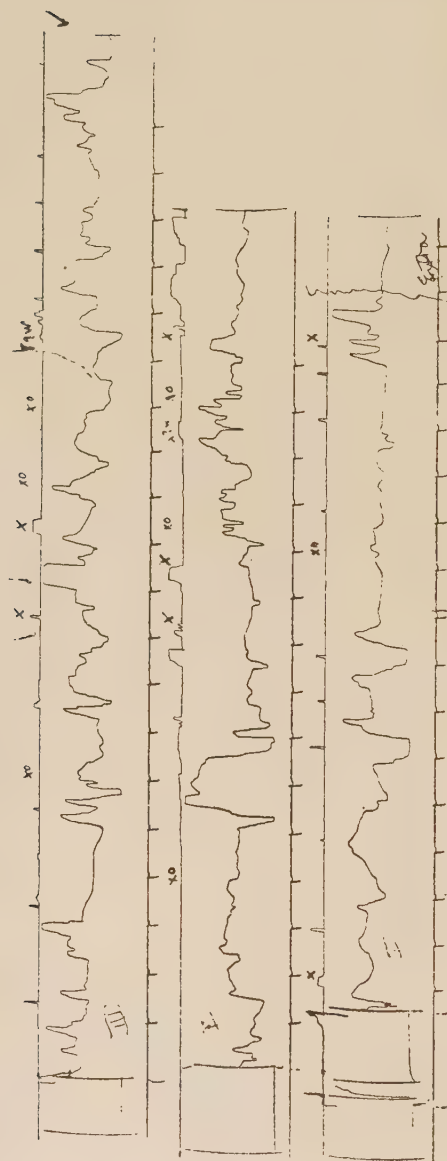


FIGURE 3
RECORD OF SUBJECT P. M., SERIES 5



FIGURE 4
RECORD OF SUBJECT D. S., SERIES 3

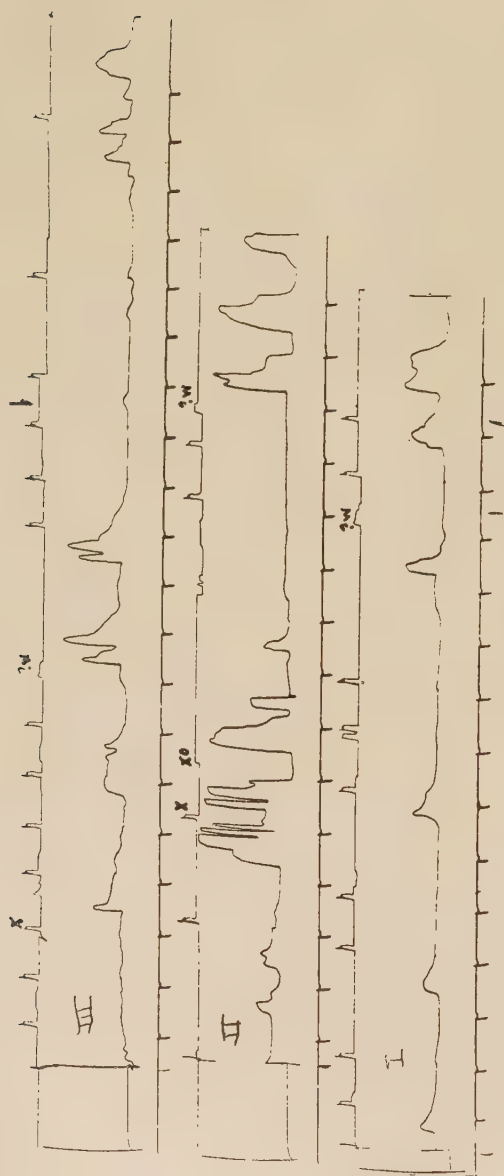


FIGURE 5
RECORD OF SUBJECT B. J., SERIES 3

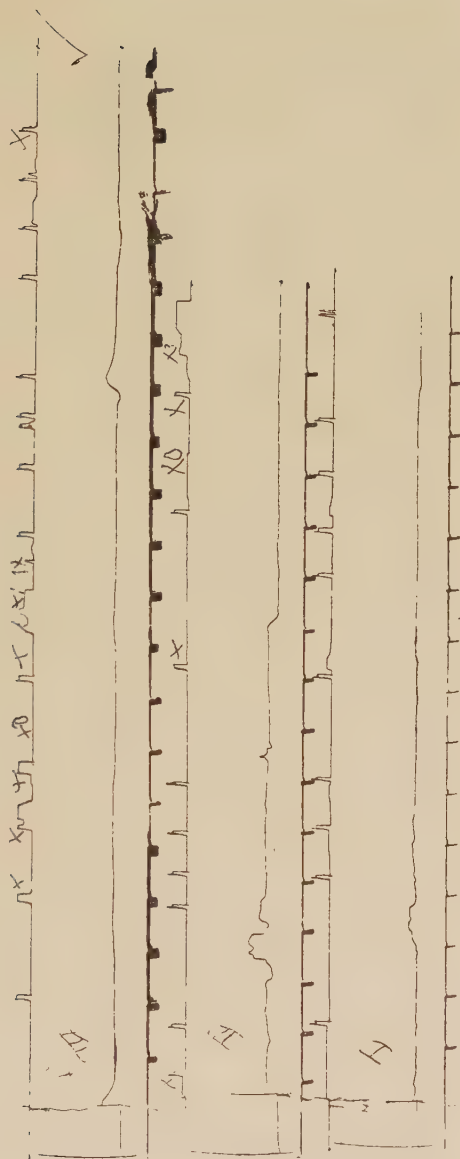


FIGURE 6
RECORD OF SUBJECT O. E., SERIES 6



FIGURE 7
RECORD OF SUBJECT C. H., SERIES 7

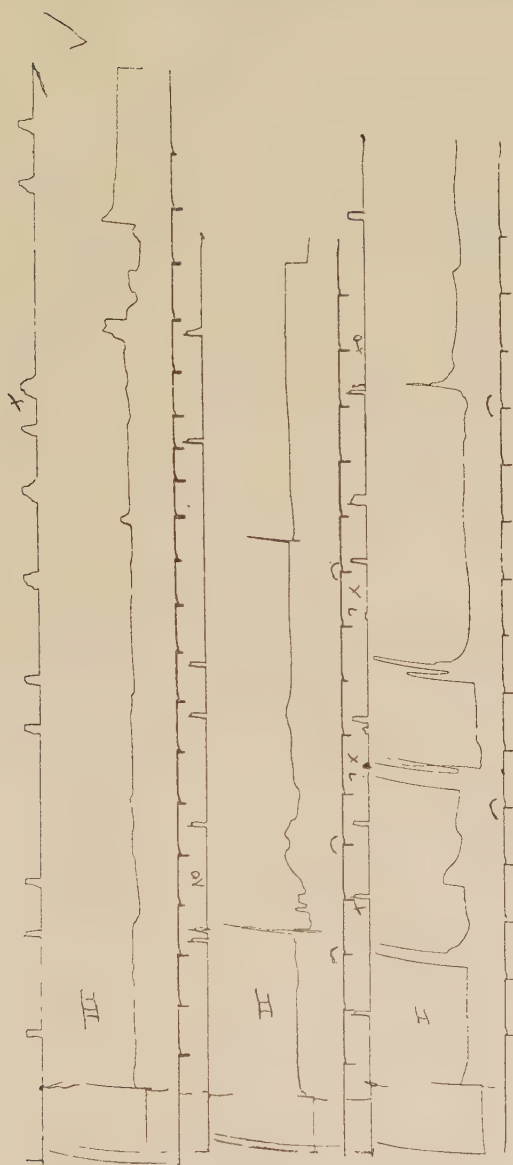


FIGURE 8

RECORD OF SUBJECT V. R., SERIES 8

The small curved marks just above the bottom line indicate the sounding of the Klaxon

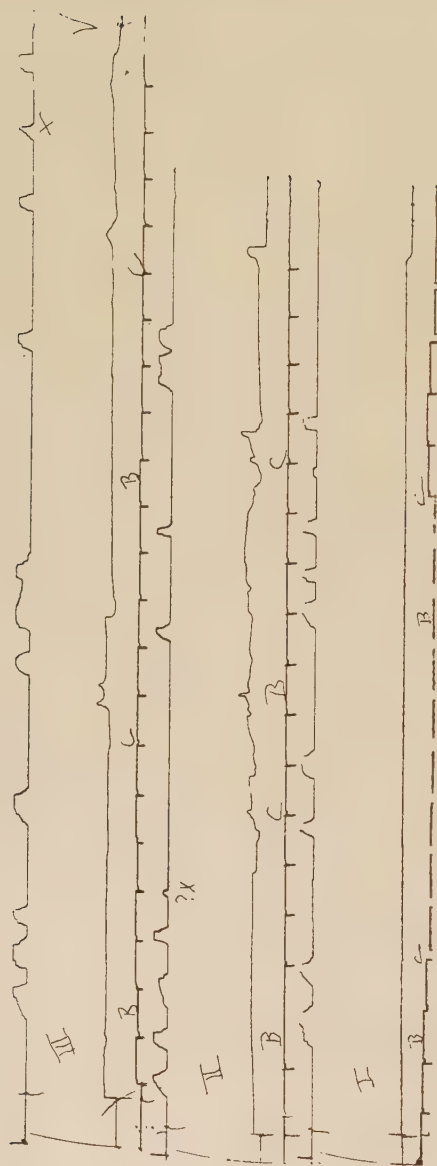


FIGURE 9

RECORD OF SUBJECT V. R., SERIES 10

The letter B indicates the ringing of the bell, the letter C indicates
the lighting of the cat's eyes

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LES TENSIONS ET LES FACTEURS ÉMOTIONNELS DE LA RÉACTION

(Résumé)

Cette enquête est une approche à l'étude des différences individuelles en ce qu'on appelle ordinairement l'excitabilité émotionnelle. Employant comme sujets des enfants âgés de trois ans et demi à cinq ans, on a fait des notations kymographiques du degré de tension des muscles de la main gauche ou main non employée, pendant que le sujet faisait avec la main droite, des réactions de discrimination à des lumières rouges et blanches. La tension a été indiquée par le degré de pression sur une poire de gomme, ou tube, tenu dans la main pendant l'épreuve. Pour chaque sujet on a fait des notations pendant onze jours non consécutifs, pendant les quatre derniers desquels on a introduit des stimuli excitatifs doux.

On a constaté des différences individuelles marquées de tension. D'ailleurs, ces différences sont restées constantes d'une manière surprenante, la notation d'un individu pour un jour tendant à montrer le même type général de ligne de tension qu'elle a montré un autre jour.

On a trouvé une corrélation approximative de la hauteur de la ligne de tension, indiquant le degré de tension, avec les notations de la maîtresse d'école sur la tendance de l'enfant à l'excitabilité. La signification de la hauteur de la ligne de tension a été montrée d'ailleurs par le fait que les stimuli excitatifs ont causé fréquemment une élévation définie de la ligne de tension au moment de leur introduction, cette élévation paraissant plus fréquemment dans les lignes de tension de ceux ayant une moyenne de résultats élevés de tension que dans les lignes de tension de ceux ayant des résultats moins élevés.

Le degré de régularité ou d'irrégularité de la ligne de tension caractéristique d'un individu a semblé avoir grand rapport à ses tendances à la coordination—, c'est-à-dire, s'il était en général bien ou mal coordonné—mais ce rapport a été simplement suggéré, pas établi expérimentalement. Cette théorie a été corroborée par les notations de l'Institut des Enfants, car un enfant avec une ligne de tension élevée et irrégulière a été souvent décrit comme balbutieur, ayant l'attention inconstante, etc., tandis qu'un enfant avec une ligne de tension élevée mais régulière a été décrit d'une manière qui indique une coordination excellente.

On n'a pu faire des conclusions très définies quand on a considéré le type de ligne de tension en son rapport avec la qualité du rendement dans les réactions de discrimination. Il paraît qu'une tension élevée ou peu élevée peut être associée à un rendement très excellent. Il y a une indication légère que l'irrégularité extrême de la ligne de tension est associée à un mauvais rendement.

DUFFY

SPANNUNGEN UND FAKTOREN DER GEMÜTSERREGUNG IN DER REAKTION

(Referat)

Die Untersuchung ist eine Annäherung an das Studium dessen, was man gewöhnlich unter Gefühlsregbarkeit versteht. Die Vpn. waren Kinder im Alter von 3 1/2 bis 5 Jahren. Man machte kymographische Platten von der Höhe der Spannung in den Muskeln der linken Hand, während die Vp.

mit der rechten Hand unterscheidende Reaktionen gegen rote und weisse Lichter zeigte. Die Spannung wurde durch die Stärke des Drucks auf eine Schlauch bemessen, die die Vp. während des Versuchs in der Hand hielt. Für jede Vp. nahm man an 11 Tagen—die nicht auf einander folgten—Platten auf, und an den letzten 4 Tagen fügte man leichte Reizmittel hinzu.

Man fand sehr entschiedene individuelle Unterschiede in der Spannung. Auch blieben diese Unterschiede überraschend konstant, d.h., die individuellen Platten zeigte denselben allgemeinen Typus der Spannungslinie an einem Tage wie an einem andern. Die Höhe der Spannungslinie, welche den Grad der Spannung zeigt, korrelierte ziemlich genau mit der Ansicht des Lehrers in Betreff der Erregbarkeit des Kindes. Die Bedeutung der Höhe der Spannungslinie wurde ferner dargetan durch die Tatsache das die hinzugefügten Reize oft eine entschiedene Erhöhung verursachten und zwar in demselben Augenblick da man sie anwandte; doch erschien diese Erhöhung häufiger in den Spannungslinien derer, die durchschnittlich hohe Spannungslinien aufwiesen als bei denen mit niedrigen Spannungslinien.

Die verhältnismässige Glätte oder Unregelmässigkeit der individuellen Spannungslinie stand scheinbar in enger Beziehung zu der Koordination d.h. in wiefern diese im allgemeinen wohl koordinirt waren—oder nur in geringem Masse—doch wurde diese Beziehung nur angedeutet nicht experimentel bewiesen. Daten aus den Verzeichnissen des Kinderinstituts unterstützten diese Theorie, denn ein Kind mit sehr hoher und unregelmässiger Spannungslinie wurde oft als stotternd mit flüchtiger Aufmerksamkeit beschrieben; wogegen ein Kind mit hoher aber glatter Spannungslinie auf eine Weise beschrieben wurde, die ausgezeichnete Koordination andeutete.

Die Beziehung des Typus der Spannungslinie auf die Qualität der Leistung der Unterscheidenden Reaktionen lässt uns keine sehr bestimmten Schlussfolgerungen ziehen. Es scheint dass sowohl hohe wie niedrige Spannung mit sehr tüchtigen Leistungen verbunden werden kann. Doch fand man gewisse Anzeichen die darauf hindeuten dass ungewöhnlich. Unregelmässigkeit der Spannungslinie mit einer minderwertigen Qualität der Leistung verbunden ist.

DUFFY

VITA

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